# **Red Leaf Resources**

# Southwest #1 Project Area Supplemental Seep and Spring Inventory May 2013

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#### **ACRONYMS AND ABBREVIATIONS**

bgs below ground surface

cfs cubic feet per second

GIS Geographic Information Systems

gpm gallons per minute

GPS Geographic Positioning System

JBR Environmental Consultants, Inc.

LMO Large Mining Operations

NOI Notice of Intent

NWIS National Water Information System

RLR Red Leaf Resources, Inc.

SITLA State Institutional Trust Land Association

SMO Small Mining Operations

UDOGM Utah Division of Oil, Gas, and Mining

UDWR Utah Division of Water Rights

USEPA United States Environmental Protection Agency

USGS United States Geological Service

WRCC Western Regional Climate Center

#### 1.0 INTRODUCTION

The Red Leaf Resources, Inc., (RLR) Southwest #1 Project Area (Project Area) is located on School and Institutional Trust Land Administration (SITLA) properties in eastern Utah, approximately 55 miles south of Vernal, Utah. RLR controls two SITLA mineral leases within this Project Area, which are the subject of this supplemental seep and spring inventory. Lease ML 43374 is located in Section 36, T13S, R22E. Parts of ML 50150 included in this survey are located in Sections 19 and 30, T13S, R23E, SLBM. The combined area of the two leases totals approximately 1,604 acres.

In February 2007, RLR filed the first technology patents for the EcoShale™ In-Capsule Technology for mining oil shale. The original filing was modified in February 2008 and three U.S. patents have been published while others are still in process.

In October 2008, RLR initiated construction of a test facility under its Exploration Permit. RLR has been in continuous permitted operation since 2008 with activities including site construction, testing and scale-up of the EcoShale™ In-Capsule Technology test unit, operations, and maintenance. The EcoShale™ In-Capsule Technology is used to extract kerogen deposits from sedimentary shale deposits. The operation consists of simultaneous mining of the oil shale and creating the heating capsules for processing the mined ore.

The facility is currently operating under the authority of a Small Mine Operation (SMO) Permit. RLR intends to expand activities at the Southwest #1 small mine site by converting to a Large Mining Operation (LMO). Mining will initiate in SE1/4 of Section 30, T13S, R23E, and progress east to west and south to north. RLR submitted a Notice of Intent (NOI) to Commence Large Mining Operations to the Utah Division of Oil, Gas, and Mining (UDOGM) on September 1, 2011 (RLR 2011).

This supplemental seep and spring inventory is part of baseline activities required for a revised Ground Water Discharge Permit application associated with the LMO.

### 2.0 ENVIRONMENTAL SETTING

The topography of the Project Area is relatively flat with rolling hills. The vegetative cover on the site is predominantly a grass/sagebrush community with interspersed stands of pinion and juniper. Several small, dry draws extend into the Project Area. McCoy Reservoir # 2 is located within the northern third of the Southwest #1 Project Area. The dam is in working condition with the reservoir containing water in one of its cells on May 14, 2013.

#### **Geology and Landform**

The Project Area is located in the Uinta Basin section of the Colorado Plateau physiographic province (Stokes 1986). This physiographic province is also known as the Colorado Plateaus Level III Ecoregion (Woods et al 2001).

The Uinta Basin is a structural depression. The Project Area is located in the southern part of the basin and is underlain by northwesterly dipping Tertiary strata. The region is characterized by a dissected plateau with strong relief (Stokes 1986). The approximate elevation in the Project Area ranges from 6,200 feet in the northwest corner of Section 19, T13S, R23E to 6,600 feet in the southwest corner of Section 36, T13S, R22E.

Bedrock at the Project Area is the Tertiary, oil shale-bearing Parachute Creek Member of the Green River Formation. The Parachute Creek Member consists mainly of oil shale, which is a marlstone that contains a solid hydrocarbon material known as kerogen. The oil shale interbeds with minor amounts of siltstone, sandstone, and altered volcanic tuff beds. The Mahogany Oil Shale Zone within the Parachute Creek Member will be the oil shale source for the proposed operation. Depth to the top of the Mahogany Marker, which identifies the top of the kerogen-rich Mahogany Zone, is between the surface and 160 feet below ground surface (bgs) in the Project Area. The Douglas Creek Member of the Green River Formation crops out in some of the deeper canyons in and near the Project Area (Sprinkel 2009).

#### Groundwater

The State of Utah defines an aquifer as "a geologic formation, group of geologic formations or part of a geologic formation that contains sufficiently saturated permeable material to yield usable quantities of water to wells and springs" (R317-6-1). The Utah State Water Plan (Utah Division of Water Resources 1999) refers to Mesa Verde as the regional aquifer closest to the surface in the Project Area.

Regionally, the direction of groundwater movement in this part of the Uinta Basin is toward the north and the White River. Water quality in the Mesa Verde and other regional aquifers ranges from relatively good to briny, with a range between 1,000 mg/L and 3,000 mg/L total dissolved solids expected in the aquifer underlying the Red Leaf project (Price and Miller 1975). The Mesa Verde is approximately 3,500 to 4,000 feet bgs at the Red Leaf site.

The Green River and Wasatch Formations overlie the Mesa Verde Group in the Project Area, with the Parachute Creek Member of the Green River Formation being the surface bedrock formation found throughout the majority of the Red Leaf parcels (Sprinkel 2009). The Parachute Creek Member contains the Mahogany Oil Shale zone, from which RLR would extract its ore.

According to records on file with the Utah Division of Water Rights (2011), groundwater in the vicinity of the Project Area is generally found at depths shallower than those reported by Price and Miller (1975) or Freethey and Cordy (1991) for the Mesa Verde. The shallower depths likely reflect localized, perched aquifers associated with lenses of permeable bedrock. Alluvial deposits are minimal in the lease parcels and are insufficient to meet the state definition of an aquifer.

#### 3.0 INVENTORY BOUNDARY

**Figure 1** illustrates the supplemental seep and spring inventory boundary. The inventory boundary area encompasses 8,562 acres and the following canyons or drainages, all tributaries to Sweet Water Canyon:

- Klondike Canyon
- Reservoir Canyon
- Indian Ridge Canyon

#### 4.0 INVENTORY METHODS

The supplemental seep and spring inventory involved review of maps and previously-gathered seep and spring data, field data collection, and report preparation.

#### Field data gathering

The goal of the seep and spring data gathering was to further understand the habit of occurrence of seeps and springs and to locate any previously unreported water sources in the inventory area. Key field observations and data collection included:

- Hydrophytic vegetation associated with seeps (vegetation type and extent)
- Evidence of seep flow (erosion features) as distinguished from stream flow
- Geologic origins of any flows (i.e., alluvium or bedrock [e.g., bedding plane or fracture])
- Topographic and landscape features
- Photographs of the sites, including possible seeps and of areas with no spring/seep potential except for a dry draw
- Site name or assigned site number
- Location (using GPS where sky coverage allowed, verified by map reading, or map reading alone where a GPS reading was not possible)
- Type of development if the site had been developed as part of a water right;
- Usage (wildlife or livestock sign)
- Field parameters included pH, conductivity, water temperature, and flow rate
- Note: Where flow rate could not be measured, it was estimated and noted as such.

The northern portion of the inventory area was covered primarily on foot, specifically drainage bottoms. The upper portions of the canyon drainages were also examined from the plateau. In this type of terrain, safety can be an issue and may limit the ability to access some features. For inaccessible areas or cliff faces, binocular scoping was used to scan the terrain.

One inventory team was on site for two field days, beginning May 13, 2013. This team carried a topographic map, geographic positioning system (GPS) unit, binoculars, camera, flagging, high visibility vests, field equipment (to measure pH, conductivity, temperature, and flow), and field notebook. Where no springs or seeps were identified within a given area of coverage, field notes reflected their absence. Where seep or spring sites were identified, they were photographed, and the above field parameters were recorded.

JBR was allowed access for their field crews on either lease. Reasonable access was available to all portions of the defined seep and spring inventory area.

#### **Report Preparation**

Following data compiling and analysis, JBR prepared a report documenting its findings, and which is suitable for submittal to appropriate state agencies.

#### 5.0 INVENTORY RESULTS

The first seep and spring inventory was conducted October 23-24, 2012. The following is a brief summary of the results from that initial survey:

Few seeps or springs were identified within the inventory area, with none observed in the northwestern "highland area" of upper Klondike Canyon or the majority of the main Indian Ridge Canyon. One seep was identified in a canyon tributary to Indian Ridge Canyon (in the southwest region of the study area). One spring, a seep, and a seep complex were identified in the lower portion of Klondike Canyon and two nearby tributary canyons. These seeps and springs are described in greater detail below and in the sections that follow, with photos provided in Appendix A. The only spring identified by the water rights research was found during the inventory

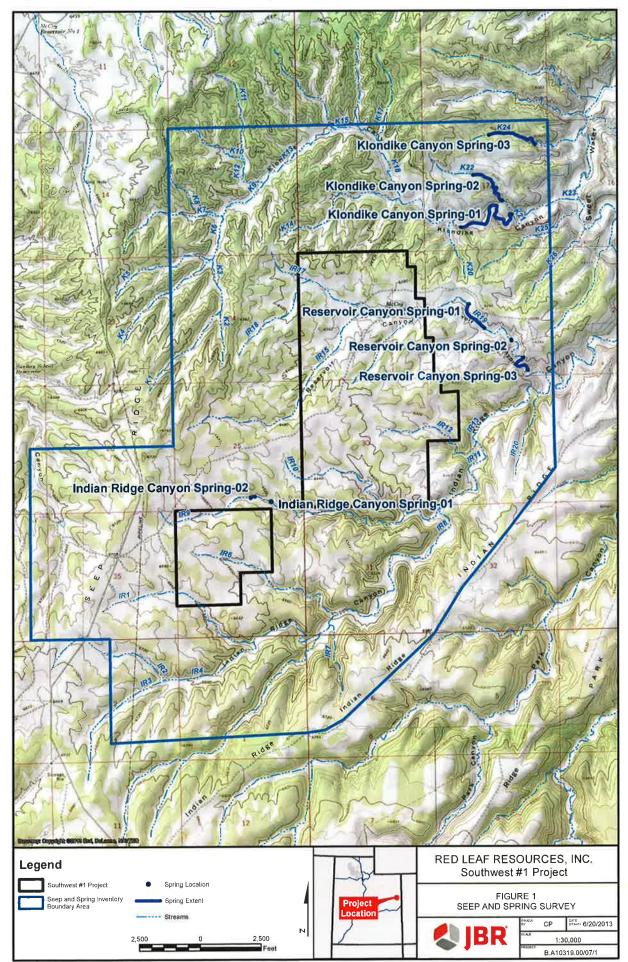
In addition, several potential seeps were identified throughout the inventory area. This includes one in a tributary canyon to Indian Ridge Canyon, four in Reservoir Canyon (also tributary to Indian Ridge Canyon), and one in a tributary canyon to Klondike Canyon. There may be additional seeps or springs issuing from the channel bottom in both the Klondike and Indian Ridge Canyon drainages that are dependent upon local, annual recharge (i.e., ephemeral or intermittent), and that were not identified due to the late fall survey window. As a result, the spring repeat survey may be able to identify additional seeps and/or springs.

The second seep and spring inventory was conducted May 13-14, 2013. This second survey was intended to verify the previously identified occurrences and to find any additional existences within the property. While additional seeps and/or springs were not identified, several areas marked as potential seeps were verified to be springs. Also, it was observed that seeps inventoried in October 2012 should now be classified as springs in May 2013. Additionally, some of the smaller, previously identified individual springs were, in fact, larger springs that were part of gaining/losing systems.

The following table (**Table 1**) illustrates the new adopted nomenclature for the individual sites to be used from this point forward.

Table 1 New Spring Nomenclature

	3		
Seep/Spring Name October 2012	New Name following May 2013 Survey		
Klondike Canyon Spring -01	Klondike Canyon Spring 01		
Klondike Canyon Seep -02	Klondike Canyon Spring 02		
Klondike Canyon Seep -03a			
Klondike Canyon Seep -03b			
Klondike Canyon Seep -03c	Klondike Canyon Spring 03		
Klondike Canyon Seep -03d			
Klondike Canyon Seep -03e			
Klondike Canyon Seep -03f			
Potential Seep 01(in Klondike Canyon)			
Potential Seep -02 (in Reservoir Canyon)	Reservoir Canyon Spring -01		
Potential Seep -03a (in Reservoir Canyon)	Reservoir Canyon Spring -02		
Potential Seep -03b (in Reservoir Canyon)			
Potential Seep -04 (in Reservoir Canyon)	Reservoir Canyon Spring -03		
Indian Ridge Canyon Seep -01	Indian Ridge Canyon Spring -01		
Potential Seep -05 (in Indian Ridge Canyon)	Indian Ridge Canyon Spring -02		



#### Klondike Canyon - Parachute Creek Member of the Green River Formation

The Parachute Creek Formation is stratigraphically the highest geologic stratum in the inventory area with spring occurrences and has the greatest areal extent. It is moderately resistant, light-to-medium-gray, light-to-medium-brown, yellow, organic-rich marlstone, siltstone, sandstone, and oolitic limestone; it contains pods of the mineral nahcolite. The spring occurrences found within the Klondike Canyon system were in the Parachute Creek Member.

#### Klondike Canyon Spring-01

This was the largest spring located within the Klondike Canyon system. It can be noted that the first emergence of water from this spring was approximately 100 yards further up the drainage channel in May 2013 than it was in October 2012. This spring initially surfaced in the bottom of the main tributary channel draining from the west to the east into Sweet Water Canyon and surfaced within the stream channel at an interface between alluvium and the Parachute Creek Formation. There was no development, and there is no water right on file with the State Engineer's Office.

At sample time (1245), water was flowing at approximately 0.42 gpm, measured using the bucket method. Flow resurfaced and went subsurface again several times within approximately 3,900 feet before going subsurface for the last time. The flow did not increase downstream or progress for a sufficient distance to support perennial stream flows in the downstream channel. There were a few tamarisk and small areas of sedges within the 300 feet; however, water was confined to the stream bottom and in most areas there was only a substrate of bedrock and gravel. Temperature was 11.8°C, pH was 8.21, and conductivity was 2.52 mS. See photos 1 – 4 in **Appendix A**.

#### Klondike Canyon Spring-02

This spring (formally designated as Klondike Canyon seep-2) was a spring that also appeared to issue from an interface between alluvium and the Parachute Creek Formation. It can be noted that the first emergence of water from this spring was approximately 50 yards further up the drainage channel in May 2013 than it was in October 2012. Surface water was present intermittently (i.e., resurfaced and went subsurface again several times) within approximately 2,100 feet before going subsurface for the last time. There was no development, and there is no water right on file with the State Engineer's Office.

There was some evidence of wildlife usage but no vegetation due to its location (bedrock and gravel). At sample time (1350), flow was not observed; there were only saturated conditions and small shallow pools in the drainage bottom. The temperature was  $19.5^{\circ}$ C, pH was 8.71, and conductivity was 1.07 mS. See photos 5-6 in **Appendix A**.

#### Klondike Canyon Spring-03

This spring site (formally designated separately as Klondike Canyon Seep-03a, Klondike Canyon Seep-03b, Klondike Canyon Seep-03c, Klondike Canyon Seep-03d, Klondike Canyon Seep-03e, Klondike Canyon Seep-03f, and Potential Seep-01), was a

spring that issued from an interface between alluvium and the Parachute Creek Formation. Surface water was present intermittently (i.e., resurfaced and went subsurface again several times) within approximately 2,200 feet before going subsurface for the last time. There was no development, and there is no water right on file with the State Engineer's Office.

There was some evidence of wildlife use but only minimal vegetation (tamarisk, grasses, and sedges at some locations). Cliff habitat was present in the surrounding area. Flow was not measured at this spring during sampling time (1035) as only saturated conditions or small shallow pools were present. The temperature was 23.7°C, pH was 8.46, and conductivity was 2.58 mS. See photos 7 – 8 in **Appendix A**.

#### Reservoir Canyon - Parachute Creek Member of the Green River Formation

There were three springs found in the Reservoir Canyon system in the Parachute Creek Member (Reservoir Canyon Seep-01, Reservoir Canyon Seep-02, and Reservoir Canyon Seep-03).

#### Reservoir Canyon Spring-01

This spring site (formally designated as Potential Seep-02), was a spring that issued from an interface between alluvium and the Parachute Creek Formation. Flow resurfaced and went subsurface again several times within approximately 1,400 feet before going subsurface for the last time. There was no development, and there is no water right on file with the State Engineer's Office.

There was some evidence of wildlife use but no changes in vegetation except for a higher concentration of grass. Flow was measured at 0.52 gpm at this spring during sampling time (1730). The temperature was  $22.4^{\circ}$ C, pH was 9.13, and conductivity was 2.54 mS. See photos 9-10 in **Appendix A**.

#### Reservoir Canyon Spring-02

This spring site (formally designated as two separate potential seeps, Potential Seep-03a and Potential Seep-03b), was a spring that issued from an interface between alluvium and the Parachute Creek Formation. Surface water was present intermittently (i.e., resurfaced and went subsurface again a couple of times) within approximately 50 feet before going subsurface for the last time. There was no development, and there is no water right on file with the State Engineer's Office.

There was some evidence of wildlife use but no changes in vegetation except for a higher concentration of grass. Flow was not measured at this spring during sampling time (1730) as only saturated conditions or small shallow pools were present. The temperature was 20.0°C, pH was 8.59, and conductivity was 2.30 mS. See photos 11 – 13 in **Appendix A**.

#### Reservoir Canyon Spring-03

This spring site (formally Klondike Canyon Seep-03a, Klondike Canyon Seep-03b, Klondike Canyon Seep-03c, Klondike Canyon Seep-03e,

Klondike Canyon Seep-03f, and Potential Seep-04, was a spring that issued from an interface between alluvium and the Parachute Creek Formation. There was an area of continuous surface water (saturated soil and shallow pools) for approximately 50 feet, where the water then went subsurface. There was no development, and there is no water right on file with the State Engineer's Office.

There was some evidence of wildlife use but no changes in vegetation except for a higher concentration of grass. Flow was not measured at this spring during sampling time (1700) as there was no visible flow (i.e., only saturated conditions or small shallow pools were present). The temperature was 26.0°C, pH was 9.74, and conductivity was 3.50 mS. See photos 14 – 15 in **Appendix A**.

Indian Ridge Canyon - Parachute Creek Member of the Green River Formation
There were two springs found in the Indian Ridge Canyon system in the Parachute
Creek Member (Indian Ridge Canyon Seep-01 and Indian Ridge Canyon Seep-02).

#### Indian Ridge Canyon Spring-01

This seep discharged from a shale bedrock outcrop at a small drop in the stream channel. There was in situ bedding of the Parachute Creek Member located immediately in the channel and on the surrounding drainage walls.

In the channel bottom was an old pipe that may have been associated with some previous development of this spring. There is a water right record on file for this spring with the State Engineer's Office. There was no riparian or wetland vegetation associated with the site, as water was confined to an area of the streambed with bedrock.

The water right associated with this seep is number 49-586 has an 1861 priority date for a flow of 0.015 cfs. Geokinetics Spring is listed as the source. The designated beneficial use for this water is for stockwatering and "other" and the status of this water right is pending adjudication claim.

There was some evidence of wildlife use, deer tracks, but no changes in vegetation. Flow was not measured at this spring during sampling time (1220) as only saturated conditions or small shallow pools were present. The temperature was 25.4°C, pH was 8.55, and conductivity was 4.56 mS. See photos 16 – 20 in **Appendix A**.

#### Indian Ridge Canyon Spring-02

This spring site (formerly designated as Potential Seep-05), was a spring that issued from an interface between alluvium and the Parachute Creek Formation. There was no development, and there is no water right on file with the State Engineer's Office.

There was evidence of wildlife in form of numerous mule deer tracks, but no changes in vegetation. Flow was not measured at this spring during sampling time (1230) as only saturated conditions or small shallow pools were present. Water resurfaced and went

subsurface again several times within approximately 240 feet before going subsurface for the last time. The temperature was  $20.5^{\circ}$ C, pH was 7.97, and conductivity was 4.20 mS. See photos 21-22 in **Appendix A**.

The following table (**Table 2**) illustrates the new locations for the individual spring sites and the photograph numbers of these sites that can be found in **Appendix A**.

Table 2 Springs Identified During the May 2013 Survey

Table 2 - Opinigo lacitante a Daning and may 2010 can bey									
Seep/Spring	Location (Headwater)	Location (Terminus)	Photos						
Klondike Canyon Area									
Klondike Canyon	109d 22.218' W	109d 21.762' W	.762' W						
Spring-01	39d 40.914' N	39d 40.998' N	1-4						
Klondike Canyon	109d 22.100' W	109d 21.845' W	5-6						
Spring-02	39d 41.271' N	39d 41.093' N	J-0						
Klondike Canyon	109d 21.953' W	109d 21.545' W	7-8						
Spring-03	39d 41.540' N	39d 41.474' N	1-0						
Reservoir Canyon Area									
Reservoir Canyon	109d 22.158' W	109d 22.025' W	9-10						
Spring-01	39d 40.387' N	39d 40.219' N	9-10						
Reservoir Canyon	109d 21.788' W	109d 21.787' W	11-13						
Spring-02	39d 40.138' N	39d 40.131' N	11-13						
Reservoir Canyon	109d 21.685' W	109d 21.646' W	44.45						
Spring-03	39d 40.013' N	39d 39.926' N	14-15						
Indian Ridge Canyon Area									
Indian Ridge Canyon	109d 23.934' W	NA	16-20						
Spring-01	39d 39.066' N	NA	10-20						
Indian Ridge Canyon	109d 24.116' W	109d 24.077' W	21-22						
Spring-02	39d 39.091' N	39d 39.100' N	Z 1-ZZ						

#### 6.0 SUMMARY

JBR conducted a seep and spring survey for RLR in May 2013 in the vicinity of the Project Area. The intent of the supplemental survey was to verify the initial baseline water resources data and to identify any additional water features. Seep and spring resources were sparse in the inventory area, with eight springs noted. **Table 3** provides a summary of the data collected.

Table 3 Seep and Springs Summary Table

Seep/Spring	Geologic Formation/Elevation (feet)	Flow (gpm)	pH (standard units)	Conductivity (mS)	Temperature (°C)
Klondike Canyon Spring-01	Alluvium/Residuum of Parachute Creek	0.42	8.21	2.52	11.8
Klondike Canyon Spring-02	Alluvium/Residuum of Parachute Creek	NA	8.71	1.07	19.5
Klondike Canyon Spring-03	Alluvium/Residuum of Parachute Creek	NA	8.46	2.58	23.7
Reservoir Canyon Spring-01	Alluvium/Residuum of Parachute Creek	0.52	9.13	2.54	22.4
Reservoir Canyon Spring-02	Alluvium/Residuum of Parachute Creek	NA	8.59	2.30	20.0
Reservoir Canyon Spring-03	Alluvium/Residuum of Parachute Creek	NA	9.74	3.50	26.0
Indian Ridge Canyon Spring-01	Alluvium/Residuum of Parachute Creek	NA	8.55	4.56	25.4
Indian Ridge Canyon Spring-02	Alluvium/Residuum of Parachute Creek	NA	7.97	4.20	20.5

#### 7.0 REFERENCES

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- Woods et al. 2001. Ecoregions of Utah (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,175,000).

# **APPENDIX A**

**Photographs** 



Photo 1 Klondike Canyon Spring – 01 looking up canyon





Photo 3 Klondike Canyon Spring – 01 looking down canyon



Photo 4 Klondike Canyon Spring – 01 looking down canyon



Photo 5 Klondike Canyon Spring – 02 looking down canyon



Photo 6 Klondike Canyon Spring – 02 looking up canyon



Photo 7 Klondike Canyon Spring – 03 looking down canyon





Photo 9 Reservoir Canyon Spring – 01 looking down canyon



Photo 10 Reservoir Canyon Spring – 01 looking up canyon



Photo 11 Reservoir Canyon Spring – 02 looking up canyon



Photo 12 Reservoir Canyon Spring – 02 looking up canyon



Photo 13 Klondike Canyon Spring – 02 looking up canyon



Photo 14 Reservoir Canyon Spring – 03 looking up canyon



Photo 15 Reservoir Canyon Spring – 03 looking up canyon





Photo 17 Indian Ridge Canyon Spring – 01 looking down canyon





Photo 19 Indian Ridge Canyon Spring – 01 looking up canyon



Photo 20 Indian Ridge Canyon Spring – 01 looking down canyon



Photo 21 Indian Ridge Canyon Spring – 02 looking up canyon



Photo 22 Indian Ridge Canyon Spring – 02 looking up canyon